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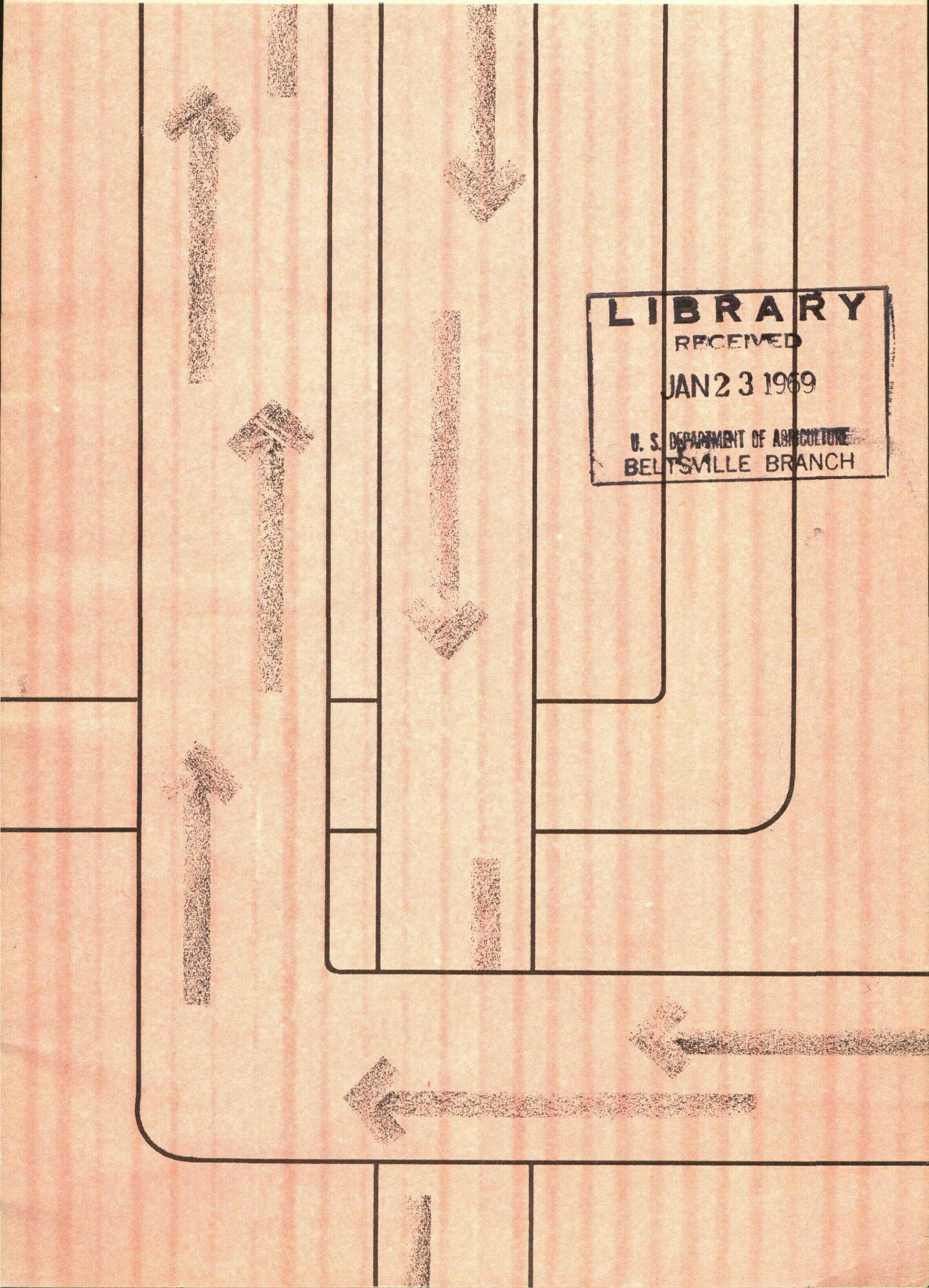
U.S. DEPARTMENT OF AGRICULTURE FARMERS' BULLETIN NO. 2235

HOME HEATING SYSTEMS/FUELS/CONTROLS



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HOME HEATING:

Systems, Fuels, Controls

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Different types of heating equipment and systems are available for heating the home. Considerations in selecting a unit or system include heating requirements, installation and maintenance costs, and heating costs. Heating-equipment dealers and contractors can assist in determining heating requirements and in selecting the most efficient and economical unit for your house.

For safety and efficiency, have a reputable contractor install your central heating system and inspect it once a year. A less costly system correctly installed will be more satisfactory than an expensive one that is not the right size for the house or that is not properly installed.

HOW TO REDUCE HEAT REQUIREMENTS

Much can be done to reduce the heat requirements in a house. This, in turn, can reduce heating costs and increase personal comfort.

New houses may be oriented so that the main rooms and the large windows in the rooms face south to receive maximum sunlight in the winter (fig. 1). (In summer, the sunlight may be shaded out by trees, wide eaves, shutters, awnings, or other natural or artificial shading.)

Tight construction also reduces heat requirements. Insulate ceilings and outside walls. Calk and weatherstrip joints. Install storm sash or double- or triple-glazed windows to reduce heat loss through the windows. An old house should always be repaired and insulated before a new heating system is installed.

The chimney is a part of the heating plant; proper construction and maintenance are important. Chimneys should extend a minimum of 2 feet above the roof ridge. Manufacturers usually specify the size of flue required for heating equipment. Keep flues clean and free from leaks.

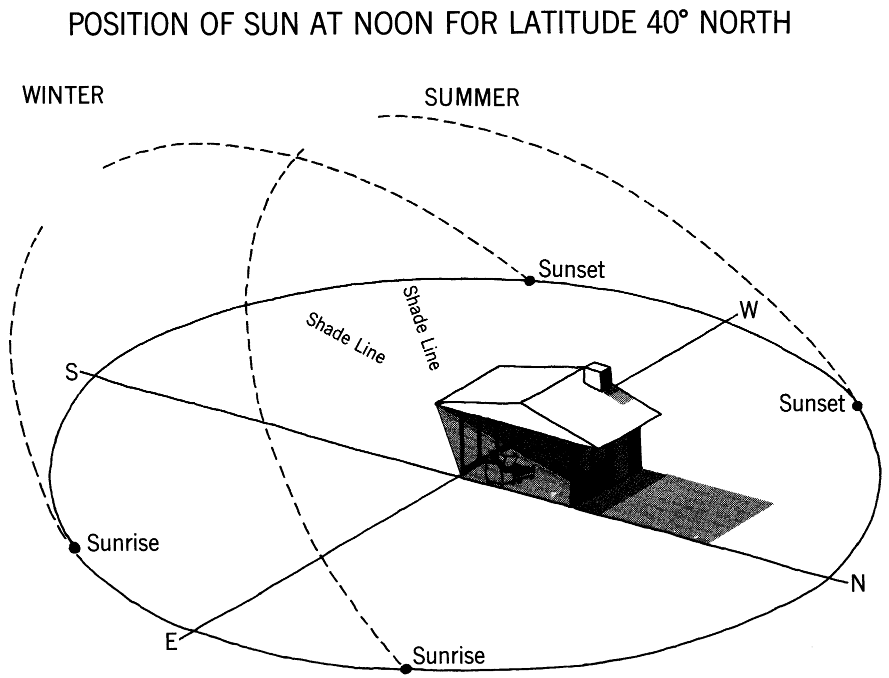

FIGURE 1.—Solar orientation of a house to reduce heat requirements. Large glass areas face south to take advantage of the winter sun which strikes the earth at a lower angle than the summer sun.

WARM AIR HEATING

Area heating units, which include stoves, circulator heaters, and "pipeless" furnaces, are installed in the room or area to be heated. In central systems, the heating unit is located in the basement or other out-of-the-way place and heat is distributed through ducts.

Central heating systems are the most efficient and economical method of heating.

It is best to buy a heating unit designed specifically for the fuel to be used. Coal or wood burners can be converted to oil or gas but usually do not have sufficient heating surface for best efficiency.

Stoves, Circulator Heaters, and Pipeless Furnaces

Stoves are one of the simplest heating devices. Although they are cheaper than central heating systems, stoves are dirtier, require more attention, and heat less uniformly. If more than one stove is used, more than one chimney may be needed.

Wood- or coal-burning stoves without jackets heat principally by radiation. Jacketed stoves or circulator heaters heat mainly by convection and are available for burning the four common fuels—wood, coal, oil, or gas.

FIREPLACES

Fireplaces are used more for personal enjoyment than for heating efficiency. They are often used to supplement other heating equipment, to take the chill off the house when it is not cold enough to run the furnace, or for emergency heating when the central system fails.

Modified fireplaces (fig. 2) are manufactured units, made of heavy metal and designed to be set in place and concealed by brickwork or other masonry construction. They are more efficient than ordinary fireplaces, because warm air is discharged from air ducts surrounding the fireplace. A fan in the duct system will improve the circulation.

Fireplace construction is covered in Farmers' Bulletin 1889, "Fireplaces and Chimneys." For a free copy, send a post card with your name and address and the number and title of the publication to the U.S. Department of Agriculture, Washington, D.C. 20250. Include your ZIP Code in your return address.

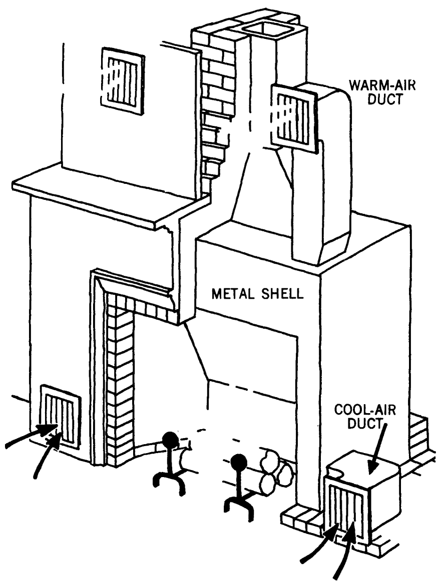

FIGURE 2.—Modified fireplaces heat more efficiently than ordinary fireplaces. Cool air enters the inlets at the bottom, is heated by contact with the warm metal of the fireplace, rises by natural circulation, and is discharged through the outlets at the top. The outlets may be located in the wall of an adjacent room or a second-story room.

With proper arrangement of rooms and doors, a circulator heater can heat four or five small rooms, but in many instances heating will not be uniform. A small fan to aid circulation will increase efficiency. The distance from the heater to the center of each room to be heated, measured through the door opening, should be not more than about 18 feet. Doors must be left open; otherwise, grills or louvers are needed at the top and bottom of doors or walls for air circulation.

"Pipeless" furnaces may be used in smaller houses. They discharge warm air through a single register placed directly over the furnace. Units that burn wood, coal, gas, or oil are available for houses with basements. Gas- and oil-burning units, which can be suspended beneath the floor, are available for houses without basements.

Small gas-fired vertical heaters are sometimes recessed in the walls of the various rooms. Such units may be either manually or thermostatically controlled. Heater vents are carried up through the partitions to discharge the burned gases through a common vent extending through the roof.

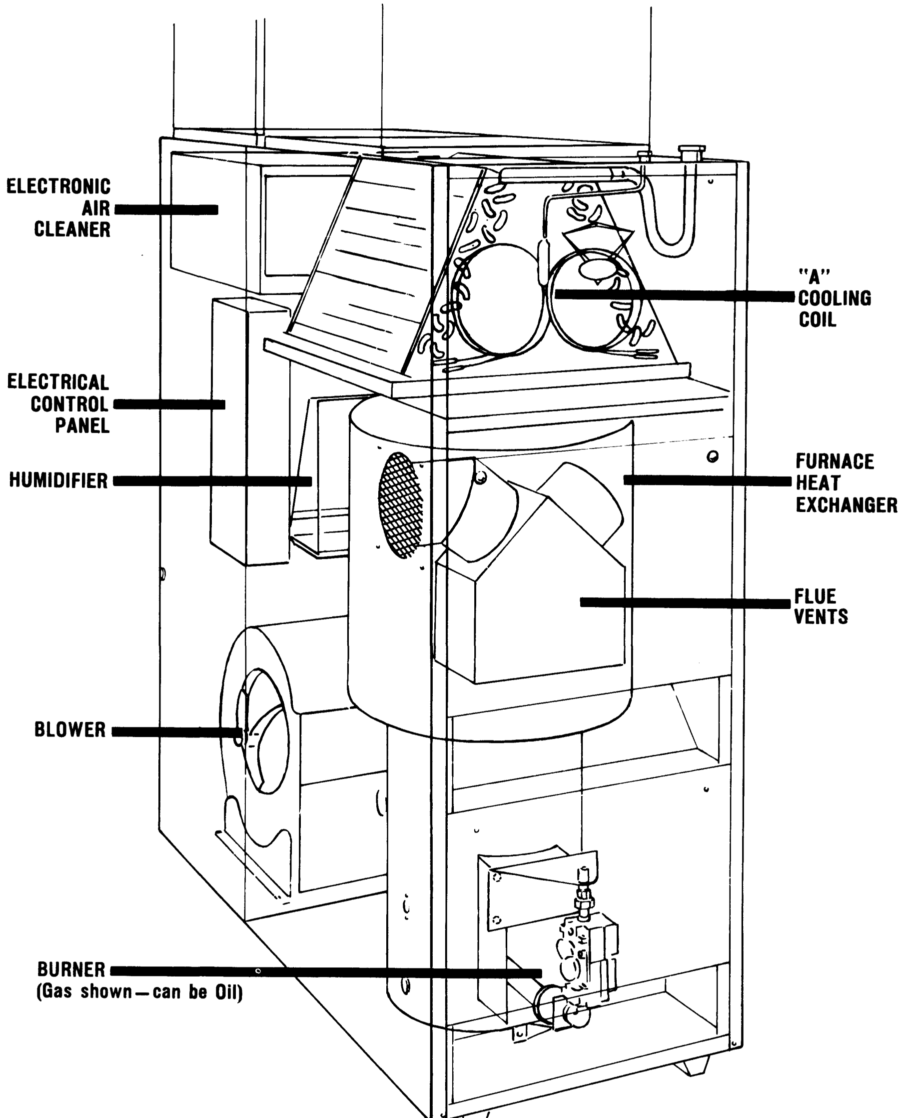

FIGURE 3.—Modern forced-warm-air furnaces may have an electronic air cleaner for better air filtration and cooling coils for summer air conditioning. This is a gas furnace.

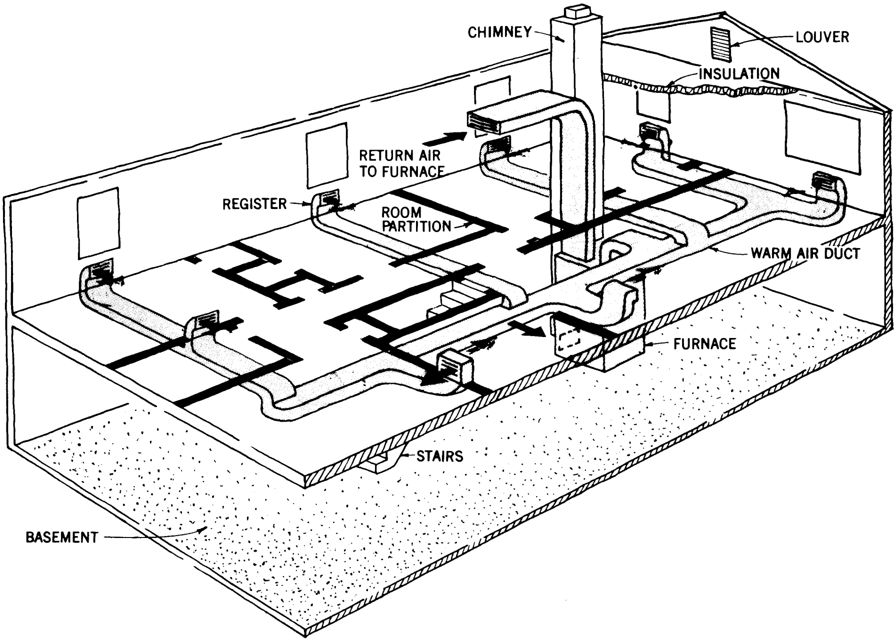

FIGURE 4.—Forced-warm-air systems are the most popular-type of heating systems. Most installations have a cold air return in each room (except the bathroom and kitchen). If the basement is heated, additional ducts should deliver hot air near the basement floor along the outside wall. In cold climates, a separate perimeter-loop heating system (fig. 6) may be the best way to heat the basement.

Central Heating Systems

Forced-warm-air heating systems are more efficient and cost less to install than gravity warm air heating systems.

Forced-warm-air systems consist of a furnace, ducts, and registers (figs. 3 and 4). A blower in the furnace circulates the warm air to the various rooms through supply ducts and registers. Return grilles and ducts carry the cooled room air back to the furnace where it is reheated and recirculated.

Forced-warm-air systems heat uniformly and respond rapidly to changes in outdoor temperatures. They can be used in houses with or without basements — the furnace need not be below the rooms to be heated nor centrally located. Some can be adapted for summer cooling by the addition of cooling coils. Combination heating and cooling systems may be installed (fig. 3). The same ducts can be used for both heating and cooling.

The warm air is usually filtered through inexpensive replaceable or washable filters. Electronic air cleaners can sometimes be installed in existing systems and are available on specially designed furnaces for new installations (fig. 3). These remove pollen, fine dust, and other irritants that pass through ordinary filters and may be better for

persons with respiratory ailments. The more expensive units feature automatic washing and drying of the cleaner.

A humidifier may be added to the system to add moisture to the house air and avoid the discomfort and other disadvantages of a too-dry environment.

Warm-air supply outlets are preferably located along outside walls. They should be low in the wall, in the baseboard, or in the floor where air cannot blow directly on room occupants. Floor registers tend to collect dust and trash, but may have to be used in installing a new system in an old house.

High-wall or ceiling outlets are sometimes used when the system is designed primarily for cooling. However, satisfactory cooling as well as heating can be obtained with low-wall or baseboard registers by increasing the air volume and velocity and by directing the flow properly.

Ceiling diffusers that discharge the air downward may cause drafts; those that discharge the air across the ceiling may cause smudging.

Most installations have a cold air return in each room. When supply outlets are along outside walls, return grilles should be along inside walls in the baseboard or in the floor. When supply outlets are along inside walls, return grilles should be along outside walls.

Centrally located returns work satisfactorily with perimeter-type heating systems. One return may be adequate in smaller houses, as shown in figure 4. In larger or splitlevel houses, return grilles are generally provided for each level or group of rooms. Location of the returns within the space is not important. They may be located in hallways, near entrance doors, in exposed corners, or on inside walls.

In the crawl-space plenum system, the entire crawl space is used as an air supply plenum or chamber. Heated air is forced into the crawl space and enters the rooms through perimeter outlets, usually placed beneath windows, or through continuous slots in the floor adjacent to the outside wall. With tight, well-insulated crawl-space walls, this system can provide uniform temperatures throughout the house. Because this system is relatively new, however, specific recommendations are not available for the most economical installation and operation.

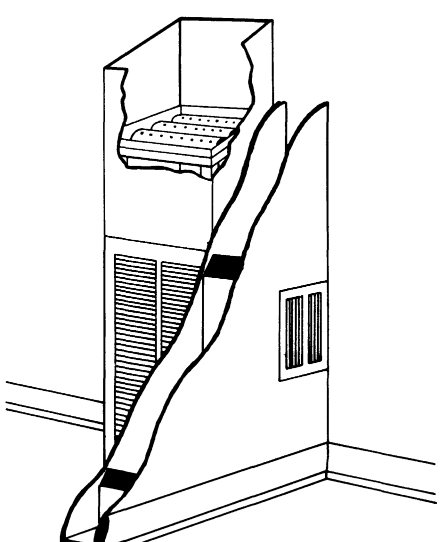

FIGURE 5.—Vertical furnaces installed in a closet or a wall recess or against the wall are popular in small houses. The counterflow type (shown here) discharges the warm air at the bottom.

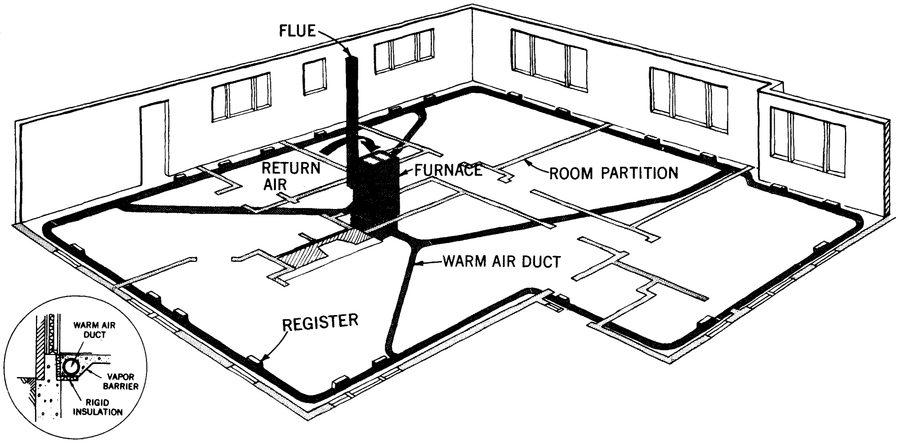

FIGURE 6.—Perimeter-loop heating systems are often used in basementless houses built on a concrete slab. The inset shows duct-slab-foundation construction details.

In houses without basements, horizontal furnaces that burn gas or oil may be installed in the crawl space or hung from ceiling joists in the utility room or adjoining garage. The gas furnaces may also be installed in attics. Allow adequate space for servicing the furnaces. Insulate attic furnaces and ducts heavily to prevent excessive heat loss.

Vertical gas or oil furnaces designed for installation in a closet or a wall recess or against a wall are popular especially in small houses. The counterflow type discharges the hot air at the bottom to warm the floor. Some, such as the gas-fired unit shown in figure 5, provide discharge grilles into several rooms.

Upflow-type vertical furnaces may discharge the warm air through attic ducts and ceiling diffusers. Without return air ducts, these furnaces are less expensive, but also heat less uniformly.

Houses built on a concrete slab may be heated by a perimeter-loop heating system (fig. 6). Warm air is circulated by a counterflow type furnace through ducts cast in the outer edge of the concrete slab. The warm ducts heat the floor, and the warm air is discharged through floor registers to heat the room.

To prevent excessive heat loss, the edge of the slab should be insulated from the foundation walls and separated from the ground by a vapor barrier.

HOT-WATER AND STEAM HEATING

Hot-water and steam heating systems consist of a boiler, pipes, and room heating units (radiators or convectors). Hot water or steam, heated or generated in the boiler, is circulated through the pipes to the radiators or convectors where the heat is transferred to the room air.

Boilers are made of cast iron or steel and are designed for burning coal, gas, or oil (figs. 7 and 8). Cast-

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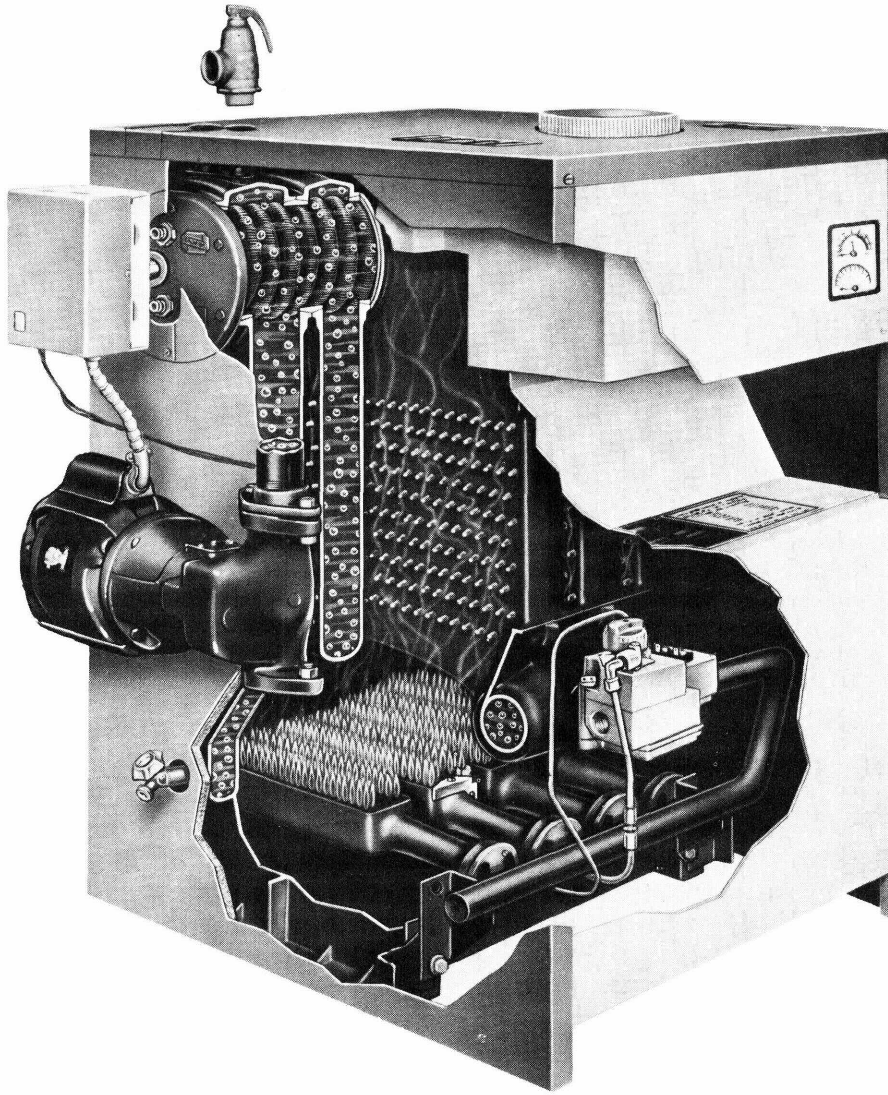

FIGURE 7.—Gas boilers are compact, self-contained units. Some units come equipped with a completely enclosing jacket.

iron boilers are more resistant to corrosion than steel ones. Corrosive water can be improved with chemicals. Proper water treatment can greatly prolong the life of steel boiler tubes.

Buy only a certified boiler. Certified cast-iron boilers are stamped "I-B-R" (Institute of Boiler and Radiator Manufacturers); steel boilers are stamped "SBI" (Steel Boiler Institute). Most boilers are rated (on the nameplate) for both hot water and steam. Contractors can advise on selecting a boiler.

Conventional radiators are set on

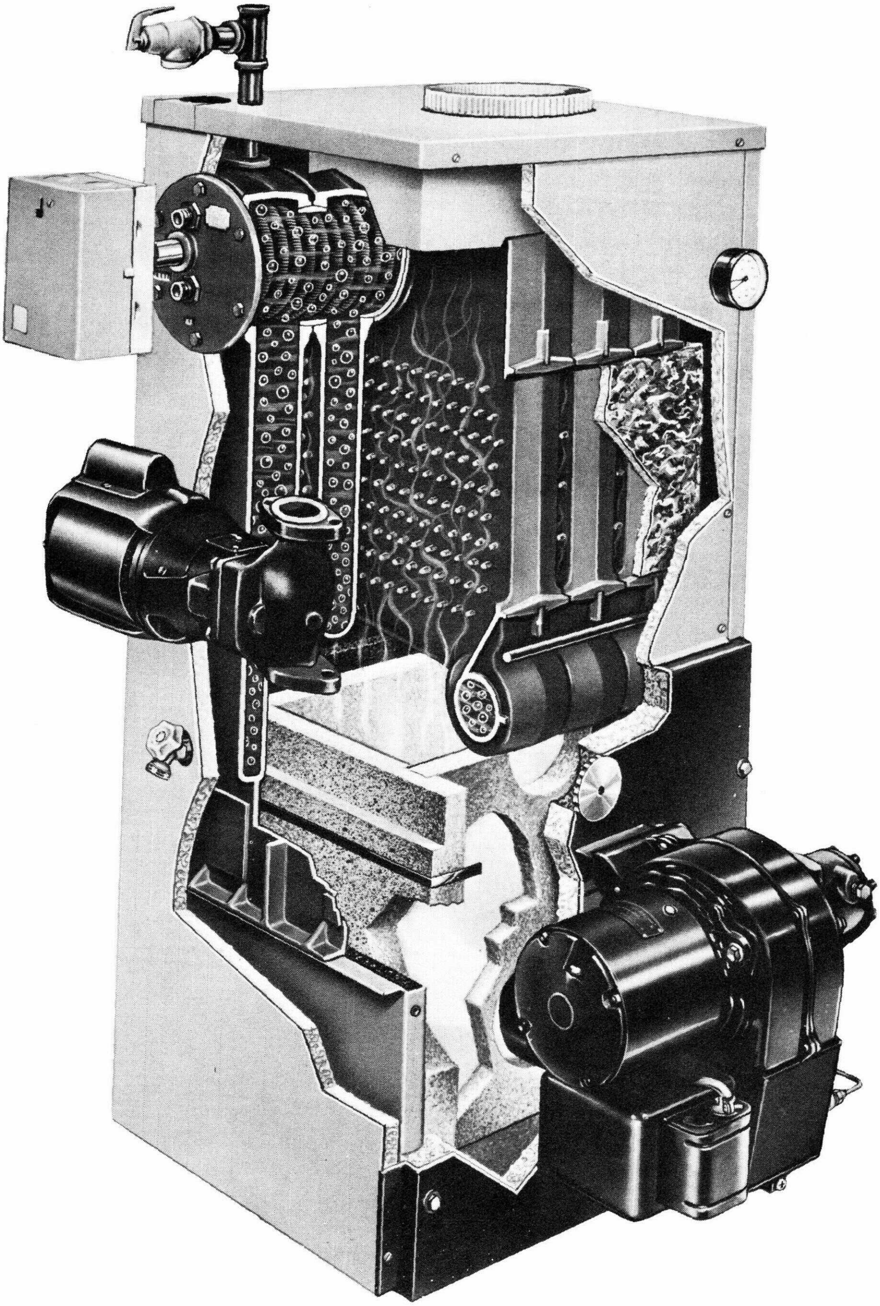

FIGURE 8.—Oil-fired boilers are also available with a completely enclosing jacket.

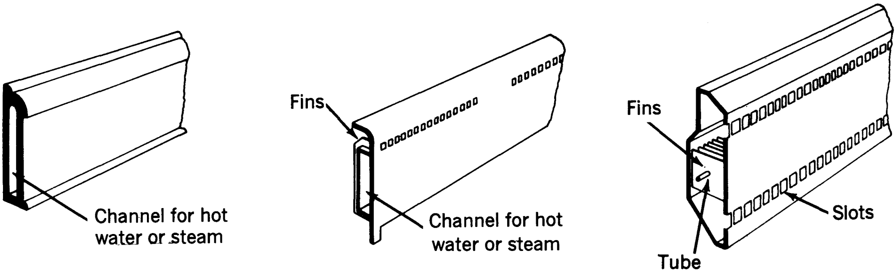

FIGURE 9.—Baseboard radiator units are designed to replace the conventional wood baseboard. In the hollow types, *A* and *B*, water or steam flows directly behind the baseboard face. Heat from that surface is transmitted to the room. In the finned-tube type, the water or steam flows through the tube and heats the tube and the fins. Air passing over the tube and fins is heated and delivered to the room through the slots.

the floor or mounted on the wall. The newer types may be recessed in the wall. Insulate behind recessed radiators with 1-inch insulation board, a sheet of reflective insulation, or both.

Radiators may be partially or fully enclosed in a cabinet. A full cabinet must have openings at top and bottom for air circulation. Preferred location for radiators is under a window.

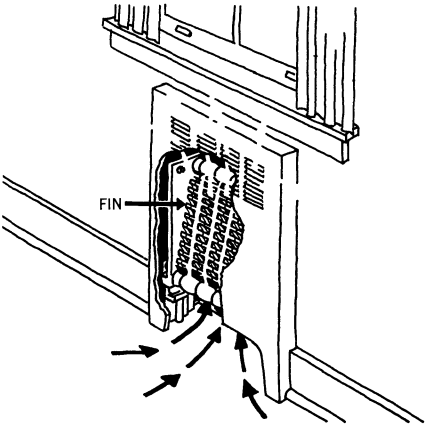

FIGURE 10.—Convectors for hot water or steam heating are installed against the wall or recessed in the wall as shown here.

Baseboard radiators (fig. 9) are hollow or finned units that resemble and replace the conventional wood baseboard along outside walls. They will heat a well-insulated room uniformly, with little temperature difference between floor and ceiling.

Convectors (fig. 10) usually consist of finned tubes enclosed in a cabinet with openings at the top and bottom. Hot water or steam circulates through the tubes. Air comes in at the bottom of the cabinet, is heated by the tubes, and goes out the top. Some units have fans for forced-air circulation. With this type of convector, summer cooling may be provided by adding a chiller and the necessary controls to the system. Convectors are installed against an outside wall or recessed in the wall.

Forced-Hot-Water Heating Systems

Forced-hot-water heating systems are recommended over the less efficient gravity hot-water-heating systems.

In a forced-hot-water system, a

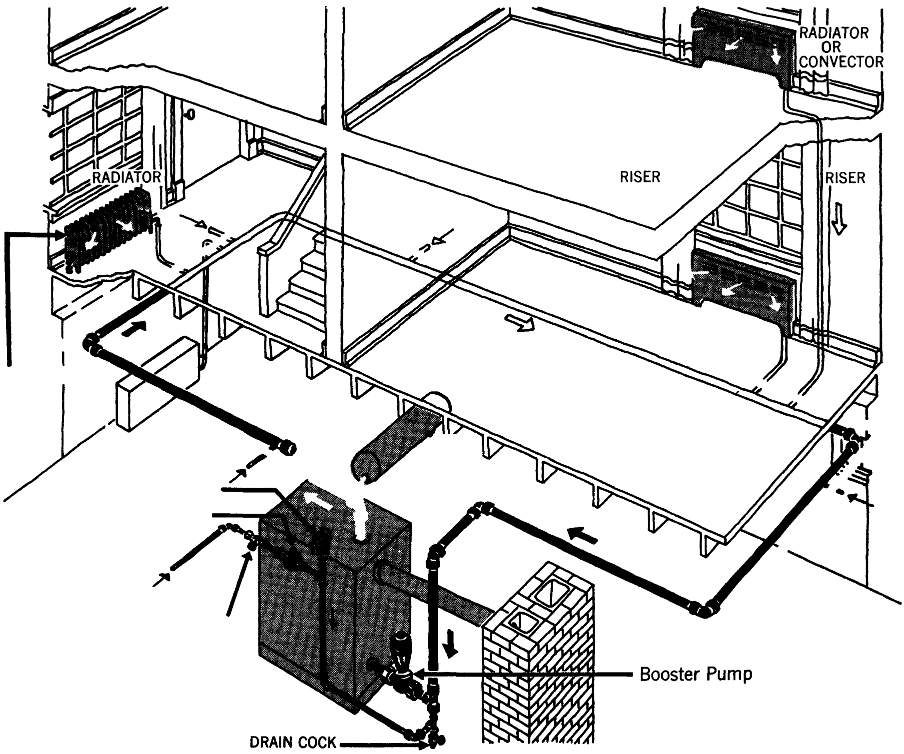

FIGURE 11.—Two-pipe forced-hot-water systems have two supply pipes or mains. One supplies the hot water to the room heating units, and the other returns the cooled water to the boiler.

small booster or circulating pump forces or circulates the hot water through the pipes to the room radiators or convectors (fig. 11).

In a one-pipe system, one pipe or main serves for both supply and return. It makes a complete circuit from the boiler and back again. Two risers extend from the main to each room heating unit. A two-pipe system has two pipes or mains. One carries the heated water to the room heating units; the other returns the cooled water to the boiler.

A one-pipe system, as the name indicates, takes less pipe than a two-pipe system. However, in the one-pipe system, cooled water from each radiator mixes with the hot water flowing through the main, and each succeeding radiator receives cooler water. Allowance must be made for this in sizing the radiators—larger ones may be required further along in the system.

Because water expands when heated, an expansion tank must be provided in the system. In an "open system," the tank is located above the highest point in the system and has an overflow pipe extending through the roof. In a "closed system," the tank is placed anywhere in the system, usually near the

boiler. Half of the tank is filled with air, which compresses when the heated water expands. Higher water pressure can be used in a closed system than in an open one. Higher pressure raises the boiling point of the water. Higher temperatures can therefore be maintained without steam in the radiators, and smaller radiators can be used. There is almost no difference in fuel requirements.

With heating coils installed in the boiler or in a water heater connected to the boiler, a forced-hot-water system can be used to heat domestic water year-round. If you want to use your heating plant to heat domestic water, consult an experienced heating engineer about the best arrangement.

One boiler can supply hot water for several circulation heating systems. The house can be "zoned" so that temperatures of individual rooms or areas can be controlled in-

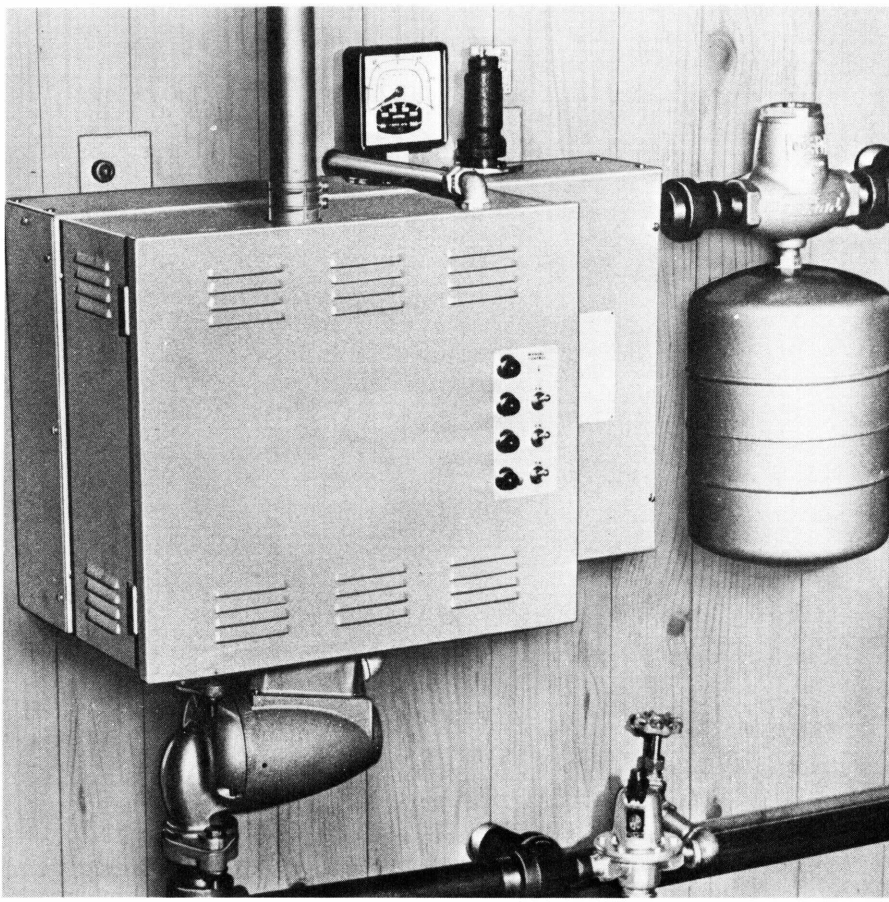

FIGURE 12.—The heat exchanger, expansion tank, and controls for an electrically heated hydronic (water) system are compact enough to mount on a wall.

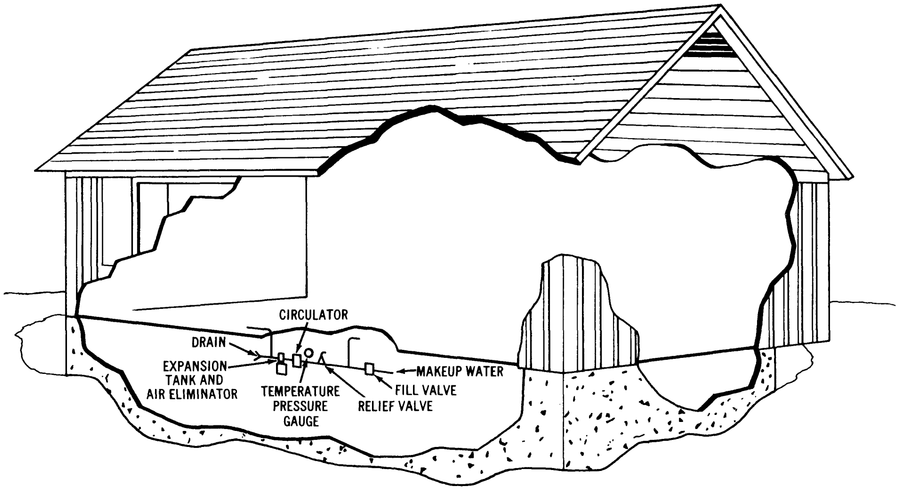

FIGURE 13.—Electrically heated hydronic baseboard systems are made in units so that several units may be connected to form a single-loop installation. Water is circulated through the entire loop by pump. Each baseboard unit has a separate heating element, so that the circulating water can be maintained at a uniform temperature, if desired, around the entire house.

dependently. Remote areas such as a garage, workshop, or small greenhouse, can be supplied with controlled heat.

Gas- and oil-fired boilers for hot-water heating are compact and are designed for installation in a closet, utility room, or similar space, on the first floor if desired.

Electrically heated hydronic (water) systems are especially compact, and the heat exchanger, expansion tank, and controls may be mounted on a wall (fig. 12). Some systems have thermostatically controlled electric heating components in the hydronic baseboard units, which eliminates the central heating unit. Such a system may be a single-loop installation (fig. 13) for circulating water by a pump, or it may be composed of individual sealed units filled with antifreeze solution. The sealed units depend on gravity flow of the solution in the unit. Each unit may have a thermostat, or several units may be controlled from a wall thermostat. An advantage of these types of systems is that heating capacity can be increased easily if the house is enlarged.

Steam Central-Heating Systems

Steam heating systems are not used as much as forced-hot-water or warm-air systems. For one thing, they are less responsive to rapid changes in heat demands.

One-pipe steam heating systems cost about as much to install as one-pipe hot-water systems. Two-pipe systems are more expensive.

The heating plant must be below the lowest room heating unit unless a pump is used to return the condensate to the boiler.

Radiant Panel Heating

Radiant panel heating is another method of heating with forced hot water or steam. (It is also a method of heating with electricity. See below.)

Hot water or steam circulates through pipes concealed in the floor, wall, or ceiling. Heat is transmitted through the pipes to the surface of the floor, wall, or ceiling and then to the room by radiation and convection. No radiators are required—the floor, wall, or ceiling, in effect, act as radiators.

With radiant panel heating, rooms can be more comfortable at lower air temperatures than with other heating systems at higher air temperatures. The reason is that the radiated heat striking the occupant reduces body heat loss and increases body comfort. Temperatures are generally uniform throughout the room.

Underfloor radiant panel heating systems are difficult to design. For instance, a carpeted or bare wood floor might be very comfortable while the ceramic-tiled bathroom floor or the plastic kitchen-floor covering might be too hot for bare feet. An experienced engineer should design the system.

Panel heating in poorly insulated ceilings is not practical unless you want to heat the space above the ceiling. Exterior wall panels require insulation behind them to reduce heat loss.

ELECTRIC HEATING

Many types and designs of electric house-heating equipment are available. Some are (1) ceiling unit, (2) baseboard heater, (3) heat pump, (4) central furnace, (5) floor furnace, and (6) wall unit. All but the heat pump are of the resistance type. Resistance-type heaters produce heat the same way as the familiar electric radiant heater. Heat pumps are usually supplemented with resistance heaters.

Ceiling heat may be provided with electric heating cable laid back and forth on the ceiling surface (fig. 14) and covered with plaster or a second layer of gypsum board. Other types of ceiling heaters include infrared lamps and resistance heaters with reflectors or fans.

Baseboard heaters resemble ordinary wood baseboards and are often used under a large picture window in conjunction with ceiling heat.

The heat pump is a single unit that both heats and cools. In winter, it takes heat from the outdoor air

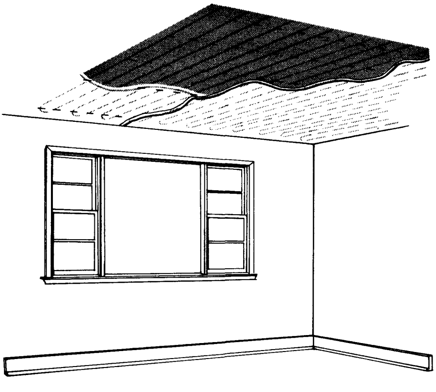

FIGURE 14.—Electric heating cable is one of the different types of electric heating used.

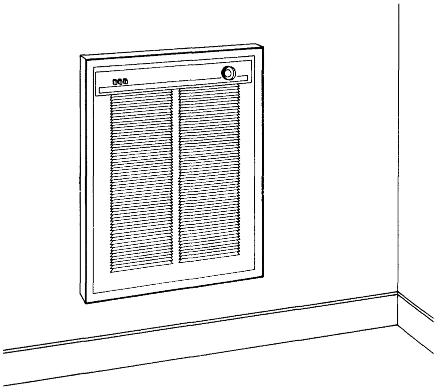

FIGURE 15.—The better types of electric wall heaters discharge the warm air from the bottom and circulate it by means of a fan.

to warm the house or room. In summer, it removes heat from the house or room and discharges it to the outside air. It uses less electricity to furnish the same amount of heat than does the resistance-type heater. Room air conditioners of the heat pump type are especially convenient in warmer climates where continuous heating is not needed or for supplemental heat in some areas of the house.

Either heat pumps or furnaces with resistance heaters are used in forced-air central heating systems. They require ducts similar to those discussed for forced warm-air heating. Hot-water systems with resistance-type heaters are also available. See section on Forced-Hot-Water Heating Systems, page 12.

Wall units (fig. 15), either radiant or convection, or both, are designed for recessed or surface wall mounting. They come equipped with various types of resistance heating elements. The warm air may be circulated either by gravity or by an electric fan.

Each room heated by the equipment just described (with the exception of some central-heating systems) usually has its own thermostat and can be held at any desired temperature. Thermostats should be designed for long life and should be sensitive to change in temperature of $\frac{1}{2}°$ F., plus or minus.

FUELS AND BURNERS

The four fuels commonly used for home heating are wood, coal, oil, and gas. Electricity, though not a fuel, is being used increasingly.

Modern heating equipment is relatively efficient when used with the fuel for which it is designed. But, even with modern equipment, some fuels cost more than others to do the same job.

Comparing Fuel Costs

The therms of heat per dollar should not be the sole consideration in selecting the heating fuel. Installation cost, the efficiency with which each unit converts fuel into useful heat, and the insulation level of the house should also be considered. For example, electrically heated houses usually have twice the insulation thickness, particularly in the ceiling and floor, and, therefore, may require considerably less heat input than houses heated with fuel-burning systems. To compare costs for various fuels, efficiency of combustion and heat value of the fuel must be known.

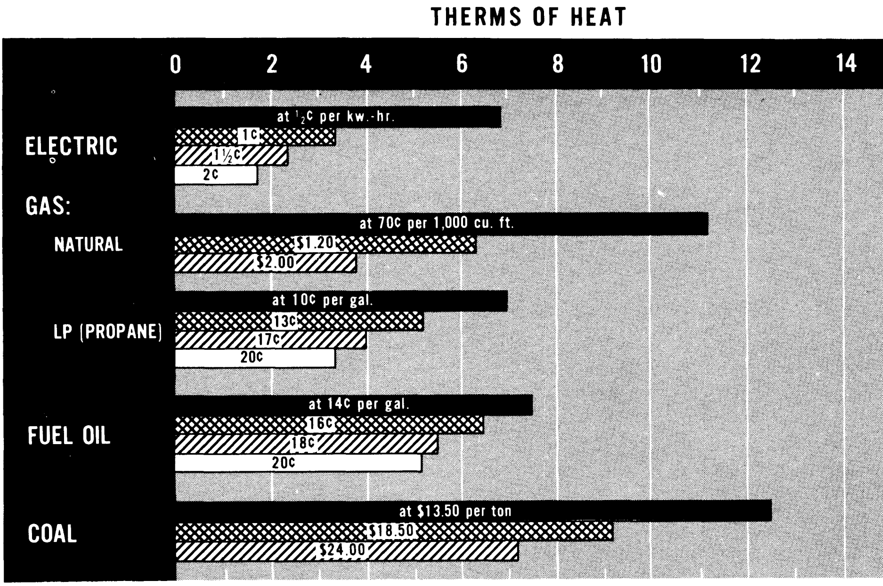

FIGURE 16.—The type of fuel, its cost, and the efficiency of the heating unit determine the number of therms of usable heat purchasable for $1. One therm equals 100,000 B.t.u.

Heating units vary in efficiency,[1] depending upon the type, method of operation, condition, and location. Stoker-fired (coal) steam and hot-water boilers of current design, operated under favorable conditions, have 60 to 75 percent efficiency. Gas- and oil-fired boilers have 70 to 80 percent efficiency. Forced-warm-air furnaces, gas fired or oil fired with atomizing burner, generally provide about 80 percent efficiency. Oil-fired furnaces with pot-type burner usually develop not over 70 percent efficiency.

Fuel costs vary widely in different sections of the country. However, for estimates, the data given in figure 16 in terms of usable heat per dollar cost can be used. Here the efficiency of electricity, gas, oil, and coal is taken as 100, 75, 75, and 65 percent, respectively. The efficiencies may be higher (except for electricity) or lower, depending upon conditions; but the values used are considered reasonable. The heat values are taken as 3,413 B.t.u. per kilowatt-hour of electricity for resistance heating; 1,050 B.t.u. per cubic foot of natural gas; 92,000 B.t.u. per gallon of propane (LP) gas; 139,000 B.t.u. per gallon of No. 2 fuel oil; and 13,000 B.t.u. per pound of coal. A therm is 100,000 B.t.u.

More B.t.u.'s of heat per kilowatt-

[1] The efficiencies in utilizing fuels given in this bulletin are recognized by the American Society of Heating, Refrigeration and Air Conditioning Engineers as being reasonable values where the heating equipment is properly installed and adjusted and in good condition.

hour can generally be obtained with heat pump heating than with resistance heating. The difference varies depending upon the outside temperature and other factors. In warm climates heat pump heating may require about half as much electricity as resistance heating. In the extreme northern States, the consumption of electric energy may approach that required for resistance heating.

Wood

The use of wood requires more labor and more storage space than do other fuels. However, wood fires are easy to start, burn with little smoke, and leave little ash.

Most well-seasoned hardwoods have about half as much heat value per pound as does good coal. A cord of hickory, oak, beech, sugar maple, or rock elm weighs about 2 tons and has about the same heat value as 1 ton of good coal.

Coal

Two kinds of coal are used for heating homes—anthracite (hard) and bituminous (soft). Bituminous is used more often.

Anthracite coal sizes are standardized; bituminous coal sizes are not. Heat value of the different sizes of coal varies little, but certain sizes are better suited for burning in firepots of given sizes and depths.

Both anthracite and bituminous coal are used in stoker firing. Stokers may be installed at the front, side, or rear of a furnace or boiler. Leave space for servicing the stoker and for cleaning the furnace. Furnaces and boilers with horizontal heating surfaces require frequent cleaning, because fly ash (fine powdery ash) collects on these surfaces. Follow the manufacturer's instructions for operating stokers.

Oil

Oil is a popular heating fuel. It requires little space for storing and no handling, and it leaves no ash.

Two grades of fuel oil are commonly used for home heating. No. 1 is lighter and slightly more expensive than No. 2, but No. 2 fuel oil has higher heat value per gallon. The nameplate or guidebook that comes with the oil burner indicates what grade oil should be used. In general, No. 1 is used in pot-type burners, and No. 2 in gun- and rotary-type burners.

For best results, a competent serviceman should install and service an oil burner.

Oil burners are of two kinds—vaporizing and atomizing. Vaporiz-

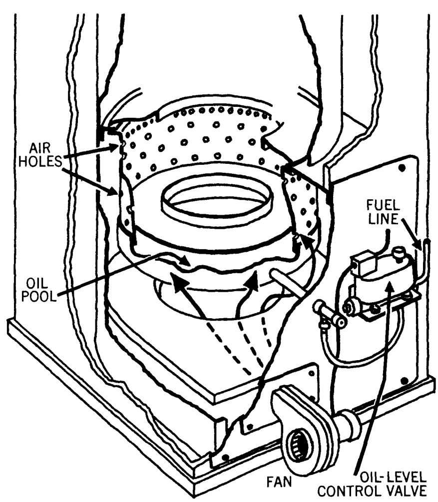

FIGURE 17.—Vaporizing or pot-type oil burners are the least expensive type.

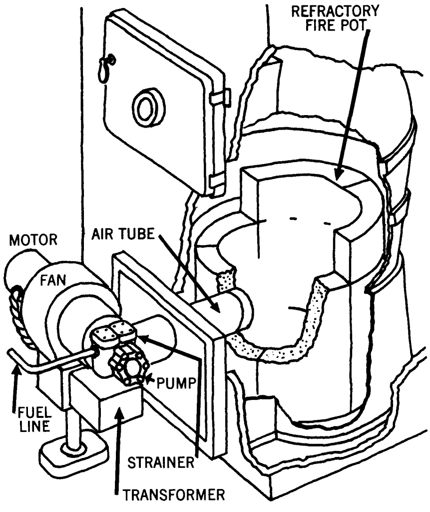

FIGURE 18.—The gun or pressure type oil burner is the most popular for home central heating systems.

ing burners premix the air and oil vapor. The pot-type burner shown in figure 17 is vaporizing and consists of a pot containing a pool of oil. An automatic or handset valve regulates the amount of oil in the pot. Heat from the flame vaporizes the oil. In some heaters a pilot flame or electric arc ignites the oil pot when heat is required; in others the oil is ignited manually and burns continuously at any set fuel rate between high and low fire, until shut off. There are few moving parts, and operation is quiet. Some pot-type burners can be operated without electric power.

Atomizing burners are of two general types—gun (or pressure) and rotary. The gun burner (fig. 18) is by far the more popular type for home heating. It has a pump that forces the oil through a special atomizing nozzle. A fan blows air into the oil fog; and an electric spark ignites the mixture, which burns in a refractory-lined firepot.

Gas

Gas is used in many urban homes and in some rural areas. It is supplied at low pressure to a burner head (fig. 19), where it is mixed with the right amount of air for combustion.

A room thermostat controls the gas valve. A pilot light is required. It may be lighted at the beginning of the heating season and shut off when heat is no longer required. However, if it is kept burning dur-

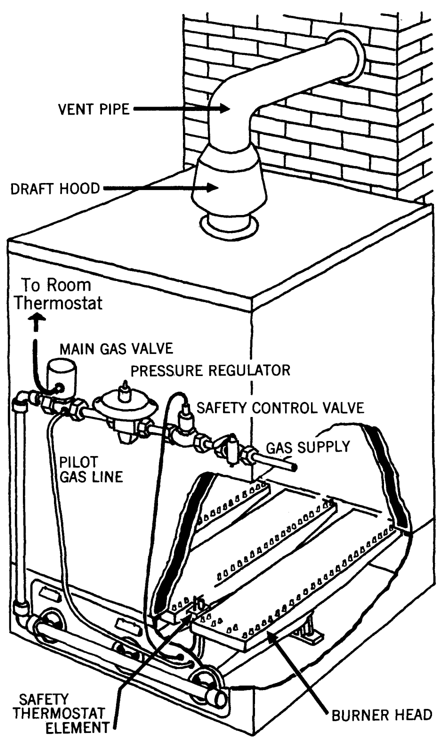

FIGURE 19.—Gas burners vary in design, but all operate on much the same principle. The controls shown are essential for safe operation.

ing nonheating seasons, condensation and rapid corrosion of the system will be prevented.

The pilot light should be equipped with a safety thermostat to keep the gas valve from opening if the pilot goes out; no gas can then escape into the room. (The pilot light of all automatic gas-burning appliances should be equipped with this safety device.)

Three kinds of gas—natural, manufactured, and bottled—are used. Bottled gas (usually propane) is sometimes called LPG (liquefied petroleum gas). It is becoming more popular as a heating fuel in recent years particularly in rural areas. Different gases have different heat values when burned. A burner adjusted for one gas must be readjusted when used with another gas.

Conversion gas burners may be used in boilers and furnaces designed for coal if they have adequate heating surfaces. Furnaces must be properly gastight. Conversion burners, as well as all other gas burners, should be installed by competent, experienced heating contractors who follow closely the manufacturer's instructions. Gas-burning equipment should bear the seal of approval of the American Gas Association.

Vent gas-burning equipment to the outdoors. Keep chimneys and smoke pipes free from leaks. Connect all electrical controls for gas-burning equipment on a separate switch so that the circuit can be broken in case of trouble. Gas-burning equipment should be cleaned, inspected, and correctly adjusted each year.

Bottled gas is heavier than air. If it leaks into the basement, it will accumulate at the lowest point and create an explosion hazard. When bottled gas is used, make sure that the safety control valve is so placed that it shuts off the gas to the pilot as well as to the burner when the pilot goes out.

Electricity [2]

Electric heating offers convenience, cleanliness, evenness of heat, safety, and freedom from odors and fumes. No chimney is required in building a new house, unless a fireplace is desired.

For electric heating to be more competitive economically with other types of heating, houses should be well insulated and weatherstripped, should have double- or triple-glazed windows, and should be vapor sealed. The required insulation, vapor barrier, and weatherproofing can be provided easily in new houses, but may be difficult to add to old houses.

Some power suppliers will guarantee a maximum monthly or seasonal cost when the house is insulated and the heating system installed in accordance with their specifications.

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[2] For additional information on electric heating and on heat pumps, see (1) REA (Rural Electrification Administration) Bulletin 142–1, "Electric House Heating", and (2) USDA Agricultural Information Bulletin 306, "Heat Pumps for Heating and Cooling Homes." Both publications are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, at 20 cents and 10 cents a copy, respectively.

The heating equipment should be only large enough to handle the heat load. Oversized equipment costs more and requires heavier wiring than does properly sized equipment.

AUTOMATIC CONTROLS

Each type of heating plant requires special features in its control system. But even the simplest control system should include high-limit controls to prevent overheating. Limit controls are usually recommended by the equipment manufacturer.

The high-limit control, which is usually a furnace or boiler thermostat, shuts down the fire before the furnace or boiler becomes dangerously or wastefully hot. In steam systems, it responds to pressure; in other systems, it responds to temperature.

The high-limit control is often combined with the fan or pump controls. In a forced-warm-air or forced-hot-water system, these controls are usually set to start the fan or the pump circulating when the furnace or boiler warms up and to stop it when the heating plant cools down. They are ordinarily set just high enough to insure heating without overshooting the desired temperature and can be adjusted to suit weather conditions.

Other controls insure that all operations take place in the right order. Room thermostats control the burner or stoker on forced systems. They are sometimes equipped with timing devices that can be set to change automatically the temperatures desired at night and in the daytime.

Since the thermostat controls the house temperature, it must be in the right place—usually on an inside wall. Do not put it near a door to the outside; at the foot of an open stairway; above a heat register, television, or lamp; or where it will be affected by direct heat from the sun. Check it with a good thermometer for accuracy.

Oil-Burner Controls

The oil-burner controls allow electricity to pass through the motor and ignition transformer and shut them off in the right order. They also stop the motor if the oil does not ignite or if the flame goes out. This is done by means of a stack thermostat built into the relay. The sensing element of the stack control is inserted into the smoke pipe near the furnace or boiler. Some heating units are equipped with electric eye (cadmium sulfide) flame detectors, which are used in place of a stack control.

Without the protection of the stack thermostat or electric eye, a gun- or rotary-type burner could flood the basement with oil if it failed to ignite. With such protection, the relay allows the motor to run only a short time if the oil fails to ignite; then it opens the motor circuit and keeps it open until it is reset by hand.

Figure 20 shows controls for an oil burner with a forced-hot-water system. The boiler thermostat acts as high-limit control if the water in the boiler gets too hot.

Stoker-Fired Coal-Burner Controls

The control system for a coal stoker is much like that for an oil burner. However, an automatic timer is usually included to operate the stoker for a few minutes every hour or half hour to keep the fire alive during cool weather when little heat is required.

A stack thermostat is not always used, but in communities where electric power failures may be long enough to let the fire go out, a stack thermostat or other control device is needed to keep the stoker from filling the cold fire pot with coal when the electricity comes on again. Sometimes a light-sensitive electronic device such as an electric eye is used. In the stoker-control setup for a forced warm-air system (fig. 21), the furnace thermostat acts as high-limit and fan control.

Gas-Burner Controls

Controls for the gas burner are so much a part of the burner itself that they have been described and illustrated in the section on gas, page 20.

Other Heating-System Controls

Warm-air, hot-water, or steam heat distribution systems may be controlled in other ways besides those suggested in figures 20 and 21. If the furnace or boiler heats domestic water, more controls are needed.

In some installations of forced hot-water systems, especially with domestic-water hookups, a mixing valve is used. The water temperature of the boiler is maintained at some high, fixed value, such as 200° F. Only a portion of this high-temperature water is circulated through the heating system. Some

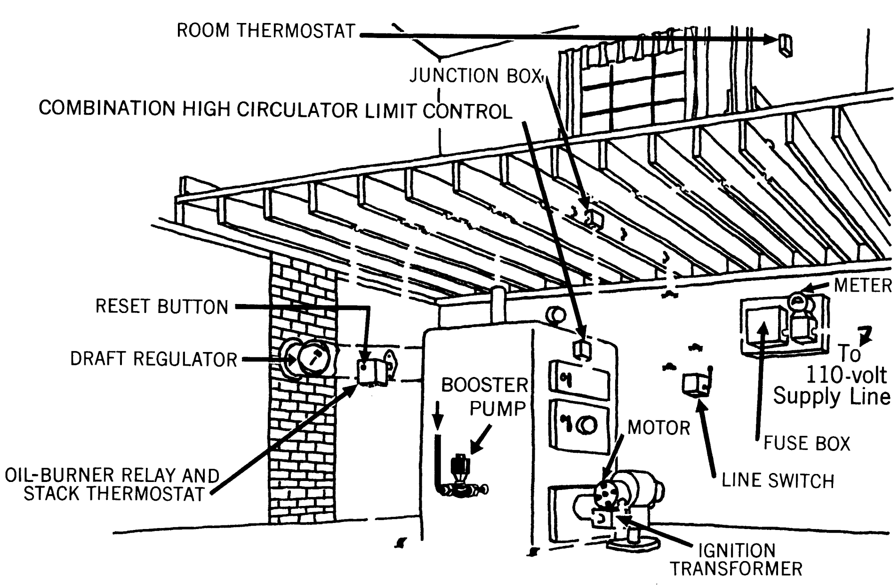

FIGURE 20.—Controls for an oil burner for a forced-hot-water heating system.

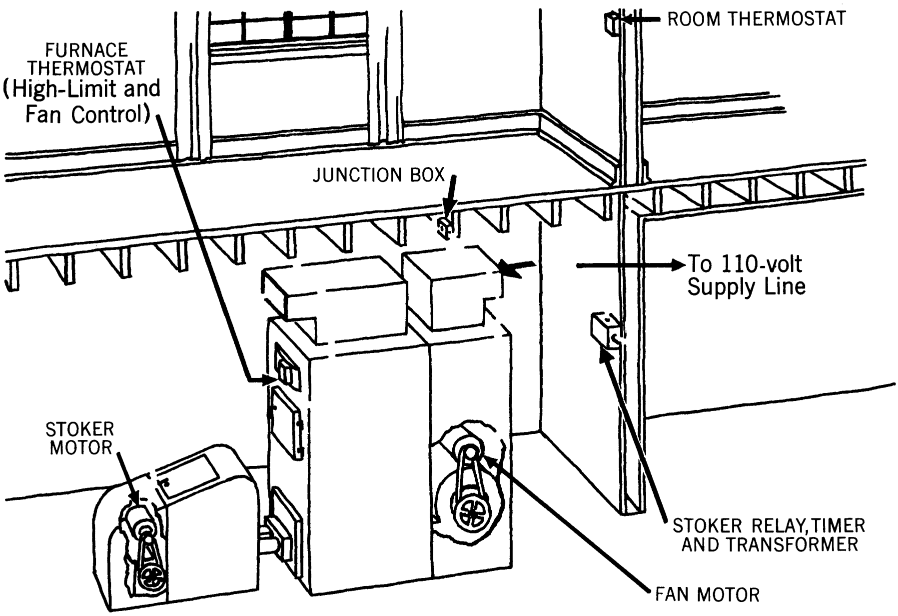

FIGURE 21.—Controls for a stoker-fired coal burner with a forced-warm-air heating system.

of the water flowing through the radiators bypasses the boiler. The amount of hot water admitted is controlled by a differential thermostat operating on the difference between outdoor and indoor temperatures. This installation is more expensive than the more commonly used control systems, but it responds almost immediately to demands; and, although it cannot anticipate temperature changes, it is in a measure regulated by outside temperatures, which change earlier than do those indoors.

The flow of hot water to each part of a building can be separately controlled. This zoning—maintaining rooms or parts of the building at different desired temperatures—can be used to maintain sleeping quarters at a lower temperature than living quarters. Electric heating is also well adapted to zoning.

Fuel savings help to offset the initial cost of the more elaborate control systems.

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